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# USSR Report

MATERIALS SCIENCE AND METALLURGY

No. 85

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## COMPOSITE MATERIALS

### COMPOSITE MATERIALS

Moscow KOMSOMOL'SKAYA PRAVDA in Russian 11 Jul 82 p 1

[Article by M. Yur'yev: "A Model of Strength"]

[Text] We are sitting in a small laboratory room, and the proprietors of it, in adjusting a microscope more conveniently, demonstrate the astonishing effect of a thin plate, on the basis of which it will be possible to make structural material unsurpassed in quality. "You understand," Anatoliy Khvostunkov, Volodya Kaz'min and Slava Kiyko, scientific collaborators of the laboratory of reinforced systems, try to convince me in unison, "we are working at the summit of materials science..."

At the most noticeable place in their laboratory there hangs the significant motto: "Think composites!" And although this definition, composite, means simply speaking, "combined," they know that it is not all so simple. To create the most modern composite metals, it is necessary to learn to think in precisely this way: contemporarily and historically, extensively and inventively, precisely and graphically concurrently. One must see the unusual in the usual, join the unjoinable and seek the unexpected solutions. It is necessary to look ahead boldly and intently delve into the past...

At all times man has solved and will continue to solve the problem of strength. And it would appear that a great number of elementary questions are asked. Why are round things broken? Why are some solids stronger than others? Why is steel ductile and glass brittle? In general, what are strength, ductility and brittleness? And are all the reserves of strength hidden in the materials used?

Sometimes it would seem to man that no problems remained, but new problems appeared, and the strength achieved was again insufficient. Let us say that rocket and space technology has created (for life) a pleiad of new materials with unprecedented excellent properties. Quite some time has passed. Space is all the more a familiar place, the amount of the payload in orbit has increased, and old materials have proved to be at the maximum of their potentialities.

And what about on earth? Let us say that the payload of a light automobile is less than the weight of the machine itself and the fuel reserve. In order to change the position radically, it is necessary to find materials which would be stronger than steel and aluminum alloys and lighter than them.

These materials are needed, of course, not only for transport. Different kinds of motors operate more efficiently, the higher the temperature of the working fluids. The struggle here often goes beyond degrees: heat-resistant materials should be strong at very high temperatures. Steel gas pipelines supply energy to Europe, but they operate in Siberia at very low temperatures where steel is brittle and very susceptible to cracks. If a crack develops in such a pipeline, then it can spread without stopping for many kilometers. The crack must be checked and stopped.

That is how the problem is raised! In order to solve it, it is necessary to "think in composites." It is necessary not just to create new materials. It is necessary to understand clearly and completely what specialists call the mechanics of destructions. Thus at the laboratory of reinforced systems of the USSR Academy of Sciences Institute of Solid-State Physics (it is the base of the Department of Mechanics of Composites of the Moscow Physicotechnical Institute), which is managed by Doctor of Technical Sciences Professor S. T. Mileyko, there are specialists in the field of electronics, acoustics, optics, mathematics, and chemistry. And in this addition of forces there is also the manifestation of their main motto: "Think in composites!"

Slava Kiyko, for example, has the task of forcing destruction to work against destruction. This means microcracks against macrocracks. From brittle components (notice, brittle as glass and stones) he has to create a crack-resistant fibrous structure.

"Look here," said Slava, and he placed photographs beside the microscope. The structure of wood is shown on them.

And under the microscope is a composite: boroaluminum (high-strength fibers of boron placed into an aluminum matrix). "You see, the structures are similar to one another. What does this mean? This is what. Mankind for thousands of years has forged metal without looking at its nature. And now when the reserve of strength of steel itself is exhausted, the composites were created. And what is astonishing is that the material, which was modeled, calculated and selected from a great number of variants under laboratory conditions, it appears, strives to become like living nature. It is the astonishing and puzzling logic of evolution. An evolution, which in passing through the 'metallic' age thrusts us forward into the stone age. Strong, light and ductile composites can be added from brittle substances."

How many secrets must still be uncovered by scientists? This work, which is for tomorrow, by roots departing into yesterday, will be completed today. And who knows, whether it is here or in the laboratory, that a metal will be created for a fantastic space flight, for future superbathyscaphes, and for machines which are lowered into the pipe of a volcano and make it possible to come into contact with new secrets.

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## NONFERROUS METALLURGY

### MINISTER URGES FULLER USE OF NONFERROUS METALS ORES

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 18 Jul 82 p 2

[Article by P. Lomako, USSR minister of nonferrous metallurgy: "Comprehensively, With Good Management"]

[Text] I am looking through work reports from leading workforces received by the ministry on the eve of Metallurgical Worker Day. Here is a report from the Bashkir Copper and Sulfur Association: "With pledges to increase by 0.2 percent the recovery of copper and zinc into concentrates, the increase was 1.5 percent." This good piece of news was sent to the ministry by A. Suvorova -- leader of one of the 18 top brigades in the nonferrous metallurgical industry which appealed to the workers of this industry to engage in socialist competition for ahead-of-schedule accomplishment of this year's targets and a worthy honoring of the 60th anniversary of establishment of the USSR.

In the Central Committee Accountability Report to the 26th CPSU Congress, Comrade L. I. Brezhnev stressed that "the successes of the entire national economy will depend in large measure on increasing the efficiency of the extractive industry. The way to achieve this is acceleration of scientific and technological advance, comprehensive, thorough processing of commercial minerals, and more extensive employment of secondary resources."

These words apply in full measure to each and every geologist and miner, beneficiation mill worker and metallurgical worker, as well as every management official in our industry. There is plenty of opportunity for us to apply our energy and knowledge. Old nonferrous metallurgical centers in the Urals and Transcaucasus are being further developed, and high-output enterprises have been built in Eastern Siberia and in the Far East, in the Ukraine and in Kazakhstan, Kirghizia, Tajikistan, Uzbekistan, Georgia, Azerbaijan, Bashkiria, and other parts of the country.

In recent years there has been a substantial increase in output volumes of basic products -- aluminum, copper, nickel, titanium, lead, tungsten, rare and other metals. In addition, recovery of valuable constituents from mineral raw materials is becoming increasingly more comprehensive: the nonferrous metallurgical industry is now providing almost three fourths of the elements in the Periodic Table.

Our enterprises have successfully set up production of mineral fertilizers, sulfuric acid, copper sulfate, as well as cement and soda products, all of which are so needed by the nation's economy. Expanded production of these items was fostered to a considerable degree by the adoption at many plants and combines of a no-waste and low-waste production process and extensive recovery of gases released during smelting and roasting ore. Suffice it to say that two thirds of the 5 million tons of sulfuric acid produced by the nonferrous metallurgical industry each year is obtained from such gases, and each ton of sulfuric acid is the basis for producing 4 tons of mineral fertilizers, expanded production of which was discussed at the May (1982) CPSU Central Committee Plenum.

The general direction of development of the nonferrous metallurgical industry is strengthening of the industry's raw materials base, its priority growth and development, increased comprehensiveness and completeness of utilization of raw materials, and the adoption of efficient industrial processes and high unit capacity equipment in the mining and processing of ores and concentrates.

An important place in this industry's comprehensive program for technological advance is occupied by measures to reduce ore losses in mining, that is, at the beginning of the production chain. Employment of a mining system involving filling mined-out cavities with hard-setting compounds has proven highly effective in this industry. Extensive adoption of such a system has made it possible to improve the operation of the Norilsk Mining and Metallurgical Combine, the Gay Mining and Beneficiation Combine, the Leninogorsk Complex Ore Combine, the Zyryanovsk Lead Combine, plus others. Based on their experience, similar projects are in process at the Orlovskiy, Tekeli, and Tishinskiy ore deposits in Kazakhstan.

The Basic Directions of Development of the National Economy in the USSR for the 11th Five-Year Plan and beyond assigns the workers of the nonferrous metallurgical industry the task of "improving the technology of mining and processing ores and concentrates, improving the comprehensiveness and completeness of utilization of mineral raw materials...." In carrying out this task the USSR Ministry of Nonferrous Metallurgy is being assisted by basic research conducted by this industry's science and institutes of the USSR, Ukrainian SSR, and Kazakh SSR academies of sciences.

A comprehensive, specific program of scientific research and experiment activities up to 1990 has been drawn up. In particular, it specifies the adoption of an ore quality control system at the junction between the mining shop and the beneficiation mill. The purpose is to improve the quality of the ore entering the mill for beneficiation, in order to compensate for the steadily declining ore grade.

New treatment processes should play an important role: flotation and froth separation with utilization of selectively acting reagents, wet magnetic separation in a high-voltage field, gravity concentration of slimes, and radiometric separation. More intensive adoption of combined schemes is planned, which will make it possible to get more metals out of low-grade concentrates, including secondary constituents.

The enterprises of this branch are more and more utilizing modern mine transport equipment, particularly self-propelled equipment, which makes it possible to boost the labor productivity of miners on the working face by 50-100 percent and more. The Achisay Complex Ore Combine, the Solnechnyy Mining and Beneficiation Combine, the Dzhezkazgan and Norilsk Mining and Metallurgical combines have been virtually fully converted over to such equipment. But this equipment is presently still in short supply.

Ore is hauled chiefly by dump trucks. Here we must lodge a complaint with the Ministry of Automotive Industry: its enterprises are slow about bringing new innovations into production and improving the technological level of the trucks they build. The 40-ton BelAZ is no longer suitable for us due to its insufficient load-carrying capacity, there are presently few 120-ton trucks in our mines, while the poorly-designed 75-ton dump truck spends more time in the shop than on the job. The Ministry of Heavy and Transport Machine Building is delaying the manufacture of underground-mine self-propelled equipment of the needed capacity.

Considerable reserve potential is to be found in beneficiation and metallurgical production. Much has been accomplished in this area, but much still remains to be done. Concentration mills are now equipped with large, high-output mills, flotation machines, and sophisticated gravity separation equipment for recovering metals from slimes. Ore processing volumes involving the self-communition method, concentration in heavy suspensions, with the aid of luminescent and froth separation are growing. The next stage is laser, electron-beam and other highly efficient processes which make it possible substantially to boost the level of recovery of valuable constituents from ores. Metallurgical shops are installing new processes, high-output equipment, and high-precision automation systems. Employment of oxygen is proving quite effective.

The workers of the aluminum industry have also contributed toward efficient utilization of raw materials. The Bratsk, Krasnoyarsk, Novokuznetsk, Tajik and several other aluminum plants are engaged in major projects to renovate equipment and adopt efficient, resource-conserving processes.

Having adopted no-waste combined nepheline processing packages, we are producing alumina, soda, potash, and belite slime, which is subsequently processed into portland cement. Last year, for example, the Volkov Aluminum Plant and the Pikalevo Alumina Association in Leningrad Oblast, as well as the Achinsk Alumina Combine, produced several million tons of cement and hundreds of thousands of tons of soda products by combined processing of nephelines.

The Ust-Kamenogorsk Lead and Zinc Combine and the Chelyabinsk Electrolytic Zinc Plant are successfully bringing a no-waste technology on-line. We recently congratulated the Chelyabinsk people: having installed a more efficient process in the sulfuric acid plant, providing additional wastewater treatment, and initiating the processing of wastewater treatment equipment sludge, they completed the transition to no-waste production.

In recent years more and more additional sources of metallurgical raw materials have been brought on-stream -- low-grade and complex ores, slags and sludges.

Their efficient utilization is an imperative task of the day. This important business, however, is not moving forward as vigorously as one would wish.

At the present time the bulk of this industry's raw material resources are concentrated in the Far North and Northeast. Many deposits of valuable non-ferrous metals are situated in the permafrost zone. Exploitation of these resources requires special arctic-model equipment, built of cold-resistant grades of steel and alloys, with insulated cabs. The enterprises of the machine building ministries, however, are very slow about moving into series production of such equipment, limiting themselves to experimental models.

Successful accomplishment of the tasks assigned to this industry is closely linked with fuller utilization of secondary resources -- nonferrous metal scrap and waste. A few days ago there was a conference of representatives of party, soviet and economic agencies, called by the CPSU Central Committee, at which an analysis was made of the state of affairs pertaining to procurement, shipping and processing of such raw materials; focal areas and practical measures to boost the level of these operations were specified. Implementation of the conference recommendations will ensure considerable economic effect.

Nonferrous metallurgical enterprises are engaged in extensive socialist competition to honor in a worthy manner the 60th anniversary of establishment of the USSR and for ahead-of-schedule fulfillment of targets and pledges for this year and the five-year plan as a whole. The workers of this industry are filled with resolve to make a weighty contribution toward implementation of the historic decisions of the 26th CPSU Congress and toward strengthening the economic potential of our homeland.

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NORILSK DIRECTOR DISCUSSES BRIGADE FORM OF WORK ORGANIZATION AT COMBINE

Moscow EKONOMICHESKAYA GAZETA in Russian No 24, Jun 82 p 10

[Article titled "The Norilsk Variant" dealing with the Norilsk Combine]

[Text] Norilsk--The Norilsk Mining and Metallurgical Combine imeni A. P. Zavyagin is the leading enterprise of nonferrous metallurgy of the country. Here brigade forms of the labor organization are widely employed, and the Scientific Organization of Labor has been incorporated. Boris Ivanovich Kolesnikov, director of the combine, tells about the accumulated experience.

He has worked here since 1950. He was a senior foreman of the copper-smelting plant, director of the nickel plant and deputy to the chief engineer of the combine. In 1969 he was promoted to chief engineer and in 1973, director of the combine.

B. I. Kolesnikov is a Hero of Socialist Labor and Deputy of the USSR Supreme Soviet.

Today our combine is a multibranch industrial-economic complex. It includes dozens of subdivisions, beginning with the mines and a system of factories and plants of the complete industrial cycle of the production of nonferrous metals and ending with plants of the economic and social infrastructure.

The combination in the north of the Krasnoyarskiy Kray of the rich mineral raw materials with the fuel-energy resources, which have been sufficiently developed by transport arteries, predetermines a high production efficiency. In the 9th and 10th Five-Year Plans, the combine experienced accelerated development. Suffice it to say that during 1976-1980 the state invested three billion rubles in the expansion of industrial production. During these years the Nadezhda Metallurgical Works, Talnakh Concentration Plant and dozens of other plants were constructed and put into operation. The production of nickel, copper and cobalt grew considerably, although the mining and geological conditions of mining of the ores are complex. At present, it is necessary to go to great depths for raw materials.

## Conversion to Brigades

The brigade forms of the organization and stimulation of labor have their own history at the Norilsk combine. Still in those years when we set about the development of the Talnakh-Oktyab'skiy deposits of copper and nickel ores and the sudden expansion of the inherent raw material base, there arose the problem which was laconically formulated thus: create large industrial collectives in a short period of time. There were few to train a considerable number of new miners. It was necessary to unite them and to mold the master's attitudes to the work to be done.

Having studied and used the experience of the leading plants as a basis, the workers, together with the economists, proposed organizing collectives at the new mines, tying labor payments of labor to the final results of mining the ore. Approved instructions and recommendations were then almost nonexistent. It was necessary to act by the "method of trial and error." Attempts were made to form highly specialized brigades, but this did not happen. Shifts were converted to a self-supporting basis, and this did not work either (one shift was uninterested in the results of the labor of another shift).

Ultimately, there was conversion to enlarged comprehensive brigades in the underground workings and mining of ore. The work of the brigades was set up through a single order. As a result, there was an overlapping of the standard periods of the construction and utilization of machinery of large underground mines. Then the concentration specialists and metallurgists converted to this form of the organization of labor.

An analysis made by us showed that at many other sections the need to create brigades became necessary long ago. Here is a simple example: in the smelting workshop of the nickel plant a large number of bridge cranes were in operation. The specific production of the repair workers servicing the cranes, of course, is not given. The industrial brigades work side by side with them. Any breakdown of the crane can disrupt and disorganize the metal production process. How is this dealt with? Do we include a mechanic in the industrial brigade?

At the nickel plant it was done a different way. At the smelting and roasting-reduction workshops brigades of repairmen were organized for servicing the cranes. Payment and bonus depend on the reliability of operation of the equipment and productive output.

At present in the industrial sphere of the Norilsk combine, almost 20,000 people are covered by brigade forms of the organization and stimulation of labor. Half of the workers engaged in the main production are united into 1250 brigades.

Depending on characteristics of the production and cooperation of labor, the self-supporting brigades are divided into two types: specialized and comprehensive. In the case of prolonged industrial cycles, continuous brigades are created. Improvement of principles of the complete set of the brigades is being continued.

The main merits of the self-supporting brigades and their advantages were greatly manifested in the course of assimilation of machinery of the Nadezhda plant.

#### Leading Forms of Labor to the New Plant

Nadezhda.... The Norilsk inhabitants for a long time have not used this word in quotations when they are speaking of the youngest plant of the combine, which was put into operation in the middle of 1981.

This plant, which is the largest in our nonferrous metallurgy industry, is unique in the technology of processing raw materials. It was as long ago as the autumn of 1979 when the first phase was prepared for being put into operation, and the Party committee and administration of the combine decided that at this plant the labor should be organized by taking into account the experience of the most advanced plants of the country. Representatives of the Nadezhda workers visited the "Kaluga turbine plant" association.

Among the initiators and supporters of brigade forms at "Nadezda," I would like especially to point out the first director, Al'bert Borisovich Voronov, and brigade foreman of the sulfur smelters, Igor' Alekseyevich Donukov.

The Kaluga variant, where planning of the brigade complete sets is accomplished, did not completely satisfy us. Therefore, it was decided to develop our own--the Norilsk variant.

A practical beginning was made with the first two comprehensive brigades. After three months seven other brigades joined them. The progressive method started roots in all the industrial processes of the plant's first phase.

We reorganized the intraplant planning and control system in the workshops. The brigades were trained in a 44-hour program. The workers selected brigade councils and a plant brigade council. Production assignments were discussed collectively and measures taken to ensure their fulfillment. Labor productivity was raised by 15%-20% with pay increases of 10%-15%. Permission was sought for the combine to provide additional material resources to stimulate the best comprehensive brigades.

Now there are 45 comprehensive brigades at "Nadezhda." Eighty-seven percent of all the workers engaged in basic production have converted to the brigade form.

However, the path to the goal has not been easy. When the comprehensive brigades were formed in the smelting workshops, then following the example of the workshops of hydrometallurgical production, repairmen were included in them. The main condition for their bonus is productive output of the workshop department and incentive indices--the timely and qualitative fulfillment of preventive maintenance of the equipment.

Decisions of the brigade council (Igor' Alekseyevich Donukov became chairman) are as authoritative and compulsory for execution as orders of the director.

The Party committee and factory committee of the trade union and now director of the plant, Dzhonson Talovich Khagazheyev, pay maximum attention to the formation of brigades.

Today at the Nadezda metallurgical plant, each worker feels as if he is a real production boss. All the information concerning production matters--from the direction of the plant to the work site and back--began to take place much more quickly and without distortions.

In order for a new assignment to be known and understood by the collective, first the chiefs of the workshops, secretaries of the Party organization and chairmen of the workshops met beforehand. They, in turn, invited chiefs of the departments and sections. Then the shift foremen were "puzzled". And only after passage along such a chain did the information "from above" reach the work sites.

Now at the Nadezhda plant, participants at sessions of the council of brigade foremen are told about the assignments received. And the workers learn of this literally in two hours. Feedback is accomplished in such order.

It would be premature to say that the work on incorporating brigade forms is completed. The Norilsk variant is constantly being improved and is acquiring great efficiency. Just recently, in the conversion process there was one comprehensive brigade, and now there are eleven. Labor productivity has grown, and the operational reliability of the equipment has been raised. Preparations are being made for the organization of two continuous comprehensive brigades in the electric furnace department.

#### How is the Competition of the Brigades Organized?

When the comprehensive brigades appeared in all the industrial processes, a more profound character was acquired at the plant by the competition under the motto, "From the early assimilation of production capacities to the superplanned production output." The comprehensive industrial brigades compete on the basis of mutual agreements. Thus seven brigades of the hydrometallurgical production and 38 brigades of the pyrometallurgical production concluded the following agreement between each other: "Concerning the early assimilation of production capacities." Monthly each brigade receives intensive obligations concerning the output of the superplanned production, which guarantee the reduction in the output time of the metallurgical plants by the planned level. Due to this, in the 11th Five-Year Plan it is planned to produce a large part of the increase in production in nonferrous metals at Norilsk.

The course of the labor rivalry of the brigades for days, ten-day periods, months, and quarter (of year) is graphically and clearly reflected. A strict accounting of additional production and its quality is kept. When it is noted that any brigade starts to lag, the next session of the council of the brigades investigates the causes and determine measures for eliminating the problem.

Positive results of work of the plant collective since the beginning of this year give every reason to confirm that the brigade method plays an important role in the assimilation of the "Nadezhda" machinery.

The administration and Party organization of the mining-metallurgical combine critically evaluate the work performed on introducing new forms of the organization of labor at the plants. We strive to see that the brigades take an interest not simply in the fulfillment of capacity indices and producing the final product of our production, but also in the achievement of these goals by the most economic means and with the minimal specific expenditures of raw materials, energy and materials. To do this will require time and perhaps a refinement of some regulating documents.

Furthermore, in our opinion, the established order of distribution of piece-work pay does not always work in the self-supporting brigade with respect to the coefficient of labor participation, which provides distribution only of the sum of the extra pay made and all forms of collective bonuses. The brigade system of the organization of labor in Norilsk is continually being developed and improved.

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## POWDER METALLURGY

### POWDER METALLURGY IN AIRCRAFT CONSTRUCTION

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 82 pp 36-37

[Article by Engr-Col Ye. Ivanov, candidate of technical sciences and docent: "Powder Metallurgy in Aircraft Construction" under the heading "Fronts of the Five-Year Plan"]

[Text]"To increase by a factor of three the production of metal powder in order to obtain products with enhanced durability, wear and corrosion resistance, and also to reduce labor and metal consumption in making machines and mechanisms." - From the Fundamental Directions for the Economic and Social Development of the USSR in the years 1981-1985 and the period up to 1990.

For the creation of new kinds of aircraft materiel, materials with high operational and productive properties are necessary. They are obtained in various ways including the method of powder metallurgy. The technology of producing these materials is rather simple. To begin with, powders are made from metals, alloys, and chemical compounds by various methods such as grinding metal chips in mills, by atomization of liquid metal with compressed air or steam, by electrolytic precipitation, by reduction from metallic oxides, and so forth. Then, a mixture is prepared from them. The material is cleansed of foreign impurities, dried, sorted according to particle size, and mixed. For the manufacture of some kinds of parts, the mixture is pressed under high pressure. Such a part, however, has little strength. In order to replace the mechanical connections between the particles with stronger interatomic connections, a part is subjected to sintering in a protective atmosphere.

This technology is different in principle from the usual methods of manufacturing parts and assemblies for aircraft and helicopters. It has a great future. In the first place, labor consumption is reduced by the process and specific metal consumption is lowered. Powder metallurgy has other advantages over the customary ways of manufacturing aircraft parts. Using it, units can be given properties that are impossible to achieve by other methods. Thus, in aircraft construction friction brake disks and welding contacts are made from an alloy of tungsten and copper. Their service life is significantly greater than that of previous products. The sintered coverings of aircraft brakes can be used over and over.

The tungsten-copper contacts used in welding machines for aircraft construction have 20 or 30 times more wear resistance than pure copper ones. The savings from the use of products made by means of powder metallurgy are very great and are expressed in hundreds of thousands or millions of rubles.

In modern aviation powdered materials are used as antifriction, friction, porous, solid, refractory, electrical, and hard alloys. The antifriction materials used in sliding bearings have a porous structure. The pores in them are filled, not with oil as in ordinary sliding bearings, but with graphite, sulphides of various metals, or teflon. These bearings can operate at temperatures of 500-700 deg. C. In addition, they can operate in a vacuum or in corrosive conditions.

Materials used for sealing the annular clearances and labyrinth glands of aviation engines, to a certain extent, can be considered as antifriction materials. In this case, a clearance calculated for the thermal expansion of the blades is left between the engine casing and the ends of the blades. Too large a clearance reduces engine efficiency. The application here of a sealing layer avoids this loss. During expansion the blades cut out grooves in the sealing layers made of sintered materials. The best of them are materials based on systems of nickel-chromium alloy and graphite or nickel-chromium alloy and boron nitride.

The increased demands for heat capacity in friction brake parts in aviation compelled a turning away from materials of the asbestos type to powdered materials. In braking during the landing of an aircraft, for 30-40 seconds, more than 400 MW of power must be absorbed. Because of this, the temperature of the braking gear rises and the coefficient of friction is reduced. Powder metallurgy materials are able to sustain a stable coefficient of friction. They wear but little over a wide range of temperatures. Materials made from refractory compounds, particularly carbides and borides of titanium are considered promising for aviation brakes.

Porous sintered materials are used in the manufacture of filters for cleaning solid particles from liquids and gases and also for cooling various subassemblies in modern flying vehicles. In the production of fine cleaning filters in foreign and domestic aircraft construction filter-grade paper, fiber, special kinds of felt, metallic gauzes, fluoroplastic, nylon, and other porous materials are widely used. In the process of using filter elements under conditions of high pressure and temperature, water and glue may be separated from them. Such parts have a short service life because they are not temperature resistant. Their temperature limits do not exceed 150-200 deg. C. Metallic gauze filter elements do not clean as well as elements made of paper and felt.

High thermal resistance (from - 250 to +3000 deg. C) and good cleaning are provided by filter elements made from porous materials. Their fineness of cleaning reaches 2-3 micrometers. Furthermore, porous filters are readily reclaimable, are not difficult to make, and have high productive qualities - they can be welded, soldered and rolled. Our industry is now producing porous bronze filter elements for fine cleaning AMG-10 liquid. They are for the FG-11 series of filters with an output of up to 40 liters/min. The porous bronze filter elements used in aircraft oxygen equipment are especially important. They play an important role in creating normal conditions for the operation of aircraft equipment when carrying out assignments at high altitudes.

In the pavilions of the VDNKh [Exhibition of the Achievements of the National Economy] parts are shown which were manufactured from prechromatized powdered steel. This porous metal is intended for filter elements working in the liquids water, benzene, kerosene, and oils. Chromatized powders substantially increase the corrosion resistance and strength of filter elements.

Porous filters made from powdered titanium are especially important. They do not interact with a number of acids at their boiling temperatures. They have low density and provide for a fineness of cleaning down to 5 micrometers. Titanium filters are widely used in modern medicine for purifying injection solutions. The use of porous filters made of sintered materials in aviation assures reliable operation of the hydraulic and fuel systems of aircraft engines. The use of porous stainless steels in filters allows the temperature and pressure of the liquids to be increased in comparison with paper and teflon filters and it reduces the weight and dimensions of the filters compared with bronze ones.

Another purpose of porous materials is for cooling in "perspiring" elements by the dissipation of heat during the passage of coolant through a porous material. Of all the variants, the most effective is cooling by gas passing through porous metal. As a coolant for parts of aircraft and engines, air, argon, water, alcohol, and other substances are used. Porous cooling also is used in high temperature gas flow. For example, with a temperature of 3000 deg. C in a gas flow, the temperature of the wall can be successfully lowered to 800 deg C or less and with several times less coolant consumption than in the use of other cooling principles.

Powder metallurgy permits coagulating metals with nonmetals. In modern aviation equipment high altitude electrical brushes are used which are made from coagulations of graphite, copper, lead, silver, and oxides of cadmium. Sintered refractories and sintered materials with high temperature strength are especially important. Thus, engine nozzles are made from foam tungsten by cold pressing with subsequent sintering. Then they are saturated with silver. This method results in obtaining tungsten products with a density of less than 4 gram/cm<sup>3</sup> which is almost five times less than the density of solid tungsten. Such products have a sufficiently high impact strength.

Lately compressor blades and disks for gas turbine engines are being successfully developed from powdered titanium alloys. For the nozzle vanes and turbine blades of gas turbine engines silicon nitride is very promising. It has more high temperature strength, thermal stability, and heat resistance than alloys obtained on the basis of nickel now being used for this purpose.

With the aid of powder metallurgy, materials with high temperature strength are made not only from refractory compounds, but from metals too. Aluminum, dispersion hardened with aluminum oxide, is called SAP [sintered aluminum powder]. Its basic advantage over aluminum is higher strength and heat resistance. Recently SAP products have been finding more and more use in aircraft equipment. Sheathing and other subassemblies for flying vehicles which may be heated to 300-500 deg. C are made from such materials.

Many examples of the use of similar materials in aircraft construction can be cited. In particular, sintered hard alloys are used in the mechanical finishing of alloys with high temperature strength. They consist of carbides of tungsten, titanium, and tantalum suffused with cobalt. Alloys are beginning to be introduced which are based on carbides of vanadium, molybdenum, and chromium and also on borides of zirconium, titanium, and molybdenum silicide.

Diamond metallic materials are being applied successfully in the grinding of hard alloys and nitrided and case hardened steels, in the trueing of grinding wheels, and for the finishing of glass. A mineral ceramic made from oxide of aluminum is very promising for high speed cutting. It can replace hard alloys in those cases where the processing is accomplished without shocks and with relatively short feeds. Cutting tools saturated with polycrystalline diamonds of the carbon black or ballas type have found application in the machining of titanium and other hard alloys. The durability of such cutters is 6 to 10 times higher than that of cutters made from hard alloys.

As envisaged by the 26th Congress of the CPSU, the further development of powder metallurgy in the 11th Five-Year Plan will be connected with the improvement of existing production processes, the mastering of new processes, and the creation and introduction of new materials and with an important increase in the volume of production for the national economy and especially for aviation.

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9136

CSO: 1842/175

UDC: 621.762

## TEMPERATURE VARIATION OF TiB<sub>2</sub>-Fe SINTERED COMPOSITE STRENGTH

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 82  
(manuscript received 12 Jan 81) pp 94-97

ORDAN'YAN, S. S., YURIDITSKIY, B. Yu. and PANTELEYEV, I. B., Leningrad Institute of Technology

[Abstract] A study is made of the strength properties of sintered titanium diboride-based composites cemented with iron (the binder contained Mo to decrease the contact wetting angle) in flexure. Compositions containing 13, 15 and 25 vol.% metal binder were studied. The studies were performed on an installation constructed at the Lensoviet Technological Institute in the 20 to 1200°C temperature interval. It was found that TiB<sub>2</sub>-Fe based alloys are superior to standard hard alloys in terms of mechanical strength at over 900°C. Figures 3; references 7: all Russian.  
[171-6508]

UDC: 669.018

## STRUCTURAL-MORPHOLOGIC STUDY OF TITANIUM DIBORIDE UPON OXIDATION IN VARIOUS MEDIA, PART 1: OXIDATION OF TITANIUM DIBORIDE IN AIR

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 82  
(manuscript received 24 Feb 82) pp 59-63

PILYANKEVICH, A. N., PAPYAN, S. V. and LUGOVSKAYA, Ye. S., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] A study was made of the changes in surface morphology, specifics of the process of seed formation and growth of oxide layers on sintered titanium diboride specimens with porosity 15 to 20% in a tubular resistance furnace in air at 300 to 700°C over 25 to 90 hours, in boiling water at normal pressure and 100°C for 50 to 200 hours, and also in water vapor at 1.1·10<sup>5</sup> Pa and 80°C for 10 to 300 hours.

The TiB<sub>2</sub> powders were produced by the borocarbide method and specimens were sintered at 2150 ± 50°C in induction furnaces. Partial oxidation of titanium diboride during sintering was established. The phase composition of low temperature oxidation products was determined. Extreme oxidation detected at 500°C results from the specifics of oxide film growth. Figures 5; references 6:  
2 Russian, 4 Western.  
[171-6508]

UDC: 621.762

PRODUCTION OF DISPERSION-HARDENED NICKEL-TUNGSTEN-ALUMINUM ALLOY BY  
MECHANICAL ALLOYING

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 82  
(manuscript received 15 Jun 81) pp 44-47

BABICH, B. N., BERESTEN', N. Ye., VLASENKO, S. Ya., KUSTOV, Yu. A. (deceased)  
and ROMANOVICH, I. V., Moscow

[Abstract] A study was made of the conditions of producing a dispersion-hardened Ni-W-Al alloy by mechanical alloying. Aluminum was introduced to provide additional hardening and because of the aging effect which gives it scale resistance which is necessary for high temperature use. The initial powder consisted of  $\text{Ni} + 17\% \text{W} + 1.3\% \text{Y}_2\text{O}_3$ , which was reduced at  $900^\circ\text{C}$  from oxides. X-ray analysis confirmed the formation of the homogeneous solid solution of tungsten in nickel. The aluminum was added to a nickel-aluminum master alloy ground to a powder with a mean particle size of  $\sim 100 \mu\text{m}$  containing 44.3% Al. Metallographic and x-ray structural studies after treatment in a centrifugal planetary mill show that the good homogenization achieved allows the process time to be reduced. Bars produced by extrusion of the mechanically alloyed powders have good structural homogeneity, elongated grain shape, a result of active recrystallization annealing, and good strength levels at temperatures up to  $1200^\circ\text{C}$ . Figures 3; references 8: 3 Russian, 5 Western.

[171-6508]

UDC: 669.018.95

PRODUCTION OF CERAMETS BASED ON TiC WITH VARIOUS CONTENTS OF Fe, Ni BINDERS IN  
ALTERNATING LAYERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 82  
(manuscript received 29 Feb 81) pp 39-43

KITSAY, A. A., KOZLOVSKIY, L. V., KUCHUK, N. V. and ORDAN'YAN, S. S.,  
Leningrad Institute of Technology

[Abstract] Mixtures of various compositions with 5 to 80% Fe and Ni were prepared by simultaneous vibration and milling of carbonyl Fe and Ni and TiC produced by the Donetsk Chemical Reagent Plant. The specimens were produced by pressing of plasticized and granulated mixtures in a press mold at  $\sim 100 \text{ MPa}$  into layers 0.2 mm or more thick, with 3 to 19 layers in each specimen. The structure of the powdered composite material is decisively influenced by the wetting of the solid by the liquid. Capillary forces equalize pressure in the volume of the system, causing migration of the liquid and partially equalizing the metal binder content. The initial porosity, ratio of liquid and solid phase volumes in the layers, relationship of masses of layers, and formation of the solid particle framework in the metal layer have a great influence on the process of structure formation. Figures 3; references 18: all Russian.

[171-6508]

UDC: 621.762

MECHANICAL AND HYDRAULIC CHARACTERISTICS OF TITANIUM POWDER FILTERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 82  
(manuscript received 11 May 81) pp 34-39

PAVLOV, V. A. and KUCHERENKO, V. G., Zaporozh'ye Machine Building Institute

[Abstract] Titanium filters are produced by a method developed at the Zaporozh'ye Machine Building Institute based on hydrostatic pressing of porous products from industrially produced electrolytic titanium powder and screened products of various particle sizes produced by crushing TG-Tv titanium sponge. Dimensions of filter elements are presented. The mechanical strength of the filters is evaluated by testing under internal or external pressure. The recommended pressure interval for hydrostatic pressing is 78.5 to 157 MPa. The mechanical strength of filters made of TG-Tv screened products is as much as 4 times greater than that of filters made of electrolytic powders. Filtration factors are approximately the same. Figures 4; references 16: all Russian.  
[171-6508]

## STEELS

UDC: 620.17:669.14.0.18.29

### RESISTANCE OF PIPELINE STEELS TO HYDROGEN EMBRITTLEMENT

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 18, No 3, May-Jun 82 (manuscript received 13 Jun 80) pp 89-93

IRZHOV, G. G., GOLOVANENKO, S. A. and SERGEYEVA, T. K., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] Experiments were performed under laboratory conditions with electrolytic hydrogenation in a 0.1 m solution of  $H_2SO_4$  with 0.5 g/l thiourea added.

The cathodic current density was  $50 \text{ mA/cm}^2$ . Specimens were cut from a sheet in the direction perpendicular to rolling. The degree of hydrogen embrittlement was estimated on the basis of three criteria: 1) time to rupture of continuously hydrogenated cylindrical specimens 6 mm in diameter continuously exposed to tensile stress; 2) decrease in ductility of preliminarily hydrogenated (for 2 hours) smooth specimens in comparison to nonhydrogenated specimens; and 3) degree of localization of hydrogen at the fracture. The combination of data produced indicates that normalized 17GLS-U steel has the lowest resistance to hydrogen embrittlement, and 08G2MFB and 10G2MFB steels rolled under controlled conditions the highest. Figures 4; references 7: 6 Russian, 1 Western.

[169-6508]

UDC 620.193.55

### PROBLEM OF SAFE LIMITS FOR USING 12MKh STEEL AT ELEVATED HYDROGEN PRESSURES AND TEMPERATURES

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 18, No 3, May-Jun 82 (manuscript received 26 Jun 80) pp 30-34

ARCHAKOV, Yu. I. and TESLYA, B. M., All-Union Institute of Petrochemical Processes, Leningrad

[Abstract] A study was made of the process of hydrogen corrosion and establishment of safe boundaries for the use of 12MKh steel in hydrogen. Steel specimens were held under hydrogen pressure in autoclaves with subsequent determination of the mechanical properties, carbon content and examination of microstructure. The experiments were performed at constant pressures of 4 to 100 MPa technical hydrogen, temperature 450 to 600°C. An incubation period was

observed before any mechanical property changes occurred. The studies indicated a difference in changes in mechanical properties, carbon content and microstructure under the conditions studied. The variation of time to beginning of intensive reduction in ductility of the steel as a function of temperature and pressure was determined. An equation was composed to calculate the time to the beginning of hydrogen corrosion of steel as a function of hydrogen pressure and temperature. Safe boundaries of utilization of 12MKh steel at various hydrogen temperatures and pressures were determined.  
Figures 5; references 15: 14 Russian, 1 Western.  
[169-6508]

## TITANIUM

UDC 621.791.4:539.378.3:669.295.5

### INFLUENCE OF DIFFUSION WELDING THERMAL CYCLE ON STRENGTH OF VT20 ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7  
Jul 82 pp 35-37

IVANOV, S. V., KARAKOZOV, E. S. and PIMENOVA, A. Z., Moscow Evening Institute  
of Mechanical Engineering

[Abstract] A study is made of the influence of diffusion welding parameters in the  $\beta$  area and for comparison also in the  $\alpha+\beta$  area on the mechanical and usage properties of VT20 titanium alloy (6% Al, 2.1% Zr, 1% Mo and 0.9% V). Tensile specimens were made from sheets 1.5 mm thick, vacuum annealed to imitate diffusion welding at 850 and 1050°C with holding time 1 hour and cooled to 300°C with the furnace, then in air. Smooth specimens and specimens with two lateral notches 3 mm deep and tip radius 0.1 mm were then tested. The strength characteristics of the alloy annealed to imitate diffusion welding in the  $\alpha+\beta$  area were superior to those of the alloy annealed to imitate welding in the  $\beta$  area. Under static loading conditions, welding in the  $\beta$  area can be used. Figures 2; references 3: all Russian.

[168-6508]

UDC 620.18:669.295.5

### STRUCTURE OF TITANIUM ALLOYS AND METHODS OF TESTING IT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7,  
Jul 82 pp 19-22

SHAKHANOVA, G. V. and BRUN, M. Ya., All-Union Institute of Light Alloys

[Abstract] To allow the use of methods of quantitative evaluation of structure in series testing of semifinished titanium alloy goods, the following tasks must be performed: 1) determine physically well-founded parameters which can be used for quantitative evaluation of various structural varieties; 2) develop an effective method of quantitative evaluation of these parameters; and 3) construct a scale for estimation of microstructure based on quantitative principles. This article describes progress in these three areas. The method of evaluation of structure of ( $\alpha+\beta$ ) titanium alloys has practically no limitations concerning varieties of structures tested, and the quantitative principle, which divided the structure into arbitrary units, assures objectivity and unambiguous results. References 2: both Russian.

[168-6508]

UDC 620.18:669.295.5

INFLUENCE OF STRUCTURE, SUBSTRUCTURE AND CRYSTALLOGRAPHIC TEXTURE ON  
MECHANICAL PROPERTIES OF TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7,  
Jul 82 pp 16-19

KHOREV, A. I., BABAREKO, A. A., KRASNOZHON, A. I., BETSOFEN, S. Ya., All-Union  
Institute of Aviation Materials Science, Institute of Metallurgy imeni  
A. A. Baykov

[Abstract] This work studies the influence of the phase composition, fine structure characteristics and phase texture on the mechanical properties of VT5-1, VT6s, VT14, VT23, VT15, Ti-3Al-15Mo and Ti-3Al-6Cr-6Mo in both uniaxial and biaxial extension of sheets and plates. Variations in these characteristics were created by changing the conditions of deformation and of heat treatment, by the use of heat treatment, and by the use of high temperature thermomechanical treatment and low temperature thermomechanical treatment. The effectiveness of texture hardening in biaxial symmetrical extension increases with increasing base texture intensity of the  $\alpha$  phase (0001) and decreases with increasing quantity of  $\beta$  phase in the alloys (from VT5-1 to VT14 and VT15). The use of specially regulated deformation, heat treatment and thermomechanical treatment conditions can produce changes in microstructure, substructure and crystallographic texture of titanium alloys of various classes, achieving a high level of strength in simple and complex stress states.

Figures 8; references 3: all Russian.

[168-6508]

UDC 669.295:621.785.6

INFLUENCE OF HEATING RATE FOR HARDENING ON STRUCTURE OF VT23 AND VT6 ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7,  
Jul 82 pp 14-16

IVASISHIN, O. M. and OSHKADEROV, S. P., Institute of Metal Physics,  
Ukrainian Academy of Sciences

[Abstract] The influence of heating rate on the formation of grain and intragrain structure in titanium alloys was studied. The specimens were heated in a furnace of  $0.2^{\circ}\text{C}/\text{s}$ , with holding for 30 minutes at the final temperature and continuous electric heating at 5 to  $200^{\circ}\text{C}/\text{s}$  to various temperatures in the  $\alpha+\beta$  and  $\beta$  areas with subsequent cooling in a stream of air. Rapid heating not only facilitates a change in the temperature conditions of phase conversions and production of a finer grain structure, but also allows formation of a high temperature  $\beta$  phase with intragrain structure of the desired dispersion and morphology, improving the properties of the alloy.

Figures 4; references 2: both Russian.

[168-6508]

UDC 669.295:621.785.34.061

INFLUENCE OF DURATION OF HIGH TEMPERATURE VACUUM ANNEALING ON STRUCTURE AND PROPERTIES OF TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7, Jul 82 pp 11-14

MAKSIMOVICH, G. G., SPEKTOR, Ya. I., FEDIRKO, V. N., PICHUGIN, A. T. and MOISEYEV, V. N.

[Abstract] A study is made of the influence of the duration of high temperature vacuum annealing on the structure and properties of certain titanium alloys. The studies were performed on flat specimens with gage cross section 1 x 2 mm made of type VT1-0 technical titanium,  $\alpha$  alloy PT-7M (1.8-2.5% Al; 2-3% Zr), and the pseudo- $\alpha$  alloy OT4-1 (1.0-2.5% Al, 0.7-2.0% Mn). The specimens were mechanically polished before heat treatment, then annealed for 1.5, 5 and 15 hours in a vacuum of  $<2.5 \cdot 10^{-3}$  Pa at  $850^{\circ}\text{C}$ , after heating at  $0.041^{\circ}\text{C/s}$ , then were cooled with the furnace. When the furnace reached  $300^{\circ}\text{C}$ , air was allowed in to create a thin oxide film to prevent activation of the surface. Changes which occurred under these conditions included diffusion of oxygen into the metal and formation of a surface gas-saturated layer with higher hardness, the thickness of which increased with increasing annealing time; etching of grain boundaries and creation of sublimation of microrelief on their surface; progressive surface damage, increasing thickness and defect content of surface layer with altered composition, decreasing the fatigue properties of the alloys. The optimal combination of strength, ductility and fatigue characteristics was achieved by annealing for not over 1 hour. Figures 2; references 7: all Russian.

[168-6508]

KINETICS OF ANODIC DISSOLUTION OF TITANIUM ALLOYS AT HIGH CURRENT DENSITIES

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 3, May-Jun 82  
(manuscript received 4 May 81) pp 12-15

BAYRAMYAN, A. Sh., Yerevan

[Abstract] Results are presented from studies of the process of anodic dissolution of VT5-1, VT3-1 and VT9 titanium alloys in various electrolytes at current densities of up to  $30 \text{ A/cm}^2$ . The anodic behavior of the alloys was studied in single-component and multiple-component electrolytes containing halide ions: NaCl 200 g/l, KBr 200 g/l, KCl 200 g/l, KCl+KBr 100+100 g/l, at constant temperatures of  $30^{\circ}\text{C}$ , pressure  $2.2 \text{ kgf/cm}^2$ , with the electrolyte moving through the electrode gap at 8 m/s, gap width 0.25 mm. Analysis of the results indicated that of the halogen-containing electrolytes studied the most effective was a two-component electrolyte containing 100 g/l each of potassium bromide and chloride. The optimum voltage and temperature were found to be

16-17 V and 35-40°C, with an electrolyte speed of at least 18 to 20 m/s and a current density of 50 A/cm<sup>2</sup>. The results of these studies were used as a basis for planning technological processes of working deep complex shaped holes in compressor blades by broaching and treatment of cylindrical apertures in solid parts of EKh titanium alloy by circular cutting. Figures 3; references 3: all Russian.

[167-6508]

UDC 669.295:539.213

INFLUENCE OF QUENCHING FROM LIQUID STATE ON STRUCTURE AND CORROSION PROPERTIES OF TITANIUM ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 82  
(manuscript received 10 Aug 81) pp 117-118

KOVNERISTYY, Yu. K., BOLOTINA, N. P., KAZARIN, V. I. and NAGORBINA, L. A.,  
Moscow

[Abstract] A study is made of possible factors resulting in improvement of the corrosion resistance of alloys in the systems Ti-Al-Cr-W, Ti-Al-Cr-W-B, Ti-Al-Cr-Mo and Ti-Al-Cr-Mo-B. Electrochemical theory indicates that homogeneity of the structure is an important factor in corrosion resistance. Quenching from the liquid state improves homogeneity of the phases fixed, preventing formation of chemically heterogeneous sectors resulting from slow diffusion processes. Quenching from the liquid state significantly improves the corrosion resistance of titanium alloys in a solution of 1 n HCl (by 2 to 4 orders of magnitude). Figures 3; references 2: both Russian.

[172-6508]

WELDING

UDC 621.791:678.029.433

MECHANISM OF ULTRASONIC WELDING OF COMPOSITE POLYMERS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 82 pp 42-43

MOZGOVOY, I. V., candidate of technical sciences, Omsk Polytechnical Institute

[Abstract] The process of ultrasonic welding of polymers is distinguished by high heating rates of the material. By analogy with polymerization processes in the ultrasonic welding mechanism of polymers it has been suggested that there is a stage of formation of a joint caused by chemical interaction accompanied by breaking of chemical macromolecular bonds, formation of active radicals, occurrence of secondary polymerization of oxidation, etc., and a stage resulting from physical interaction--processes of diffusion, mixing, slipping on crystal boundaries, formation of supermolecular structures, etc. This study indicates that breaking of macroscopic chains under the influence of ultrasound occurs under conditions with alternating compressive, tensile and shear stresses, high rates of deformation and low values of deformation, creating favorable conditions for occurrence of mechanochemical processes little studied to date. The mechanism of these processes remains unclear. The author studied the influence of ultrasound on a mixture of carbon black and raw rubber. The results showed that the content of carbon-rubber gel in the mixture varied inversely with temperature. When ultrasound acts on a composite polymer such as rubber mixture, new chemical bonds arise and the presence of technical carbon creates more favorable conditions for their appearance.

Figures 1; references 13: all Russian.

[173-6508]

UDC 621.791.44

COLD PRESSURE WELDING OF AD1M AND ADOO ALUMINUM THIN SHEET AND STRIP

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 82 pp 19-20

KUZIN, V. F., SAVINKIN, Yu. V. and TSYPINA, M. N., engineers, Tula Polytechnical Institute

[Abstract] A study is made of the influence of boundary conditions between the tool and the deformed metal at various slope angles of a wedge stamp on the minimum deformation of metal corresponding to the beginning of solidification.

The influence of tool geometry and operating surface condition on minimal deformation necessary for welding of AD1M aluminum thin sheet 0.3, 0.5, 0.8 4.0 and 6.0 mm thick was also studied. The experiments were performed with wedge shaped punches with angles of 7, 12 and 20° allowing the minimum degree of deformation necessary for beginning of seizing of the metal to be determined with the minimum number of experiments. The quality of cold pressure welding is influenced by tool geometry: welding quality increases with decreasing angle. Welding of aluminum 6 mm thick with a rough tool improves welding quality. The use of lubricant slightly decreases welding force. The influence of friction is insignificant during welding of thin sheet aluminum 0.3 to 0.8 mm thick. Figures 5; references 2: both Russian.

[173-6508]

UDC 621.791.754'293

#### AUTOMATIC WELDING OF TEE JOINTS OF ALUMINUM ALLOY IN 3-PHASE ARC

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 82 pp 15-16

STOLBOV, V. I., candidate of technical sciences, AKIMOV, A. V. and YEL'TSOV, V.V., engineers, Tol'yatti Polytechnical Institute

[Abstract] The purpose of this work was to produce high quality tee joints of aluminum alloys using a preformed projection on the wall of the tee, a method which has the following advantages: constant geometric dimensions of the seam, stabilization of seam metal chemical composition, no perturbing effects related to feeding welding material into the bath, and constant position of welded edges in space, which simplifies automation of the welding process. Experiments were performed on specimens of AMg61 and AMg5V 600 mm in length, with a wall thickness of 4 to 10 mm. It was found that good quality joints of aluminum alloys can be produced with wall thickness 3 to 8 mm by this method. The shape and dimensions of the projections to be preformed for best use of the method are determined. Figures 5; references 6: all Russian.

[173-6508]

## MISCELLANEOUS

### INCREASED USE IN SECONDARY RAW MATERIAL RESOURCES

Moscow PRAVDA in Russian 24 Aug 82 p 2

[Article by I. Yastrebov, first deputy chief, Department of Heavy Industry, CPSU Central Committee: "Secondary Metal Resources"]

[Text] The proprietary attitude toward public property and the guarding of each kilogram of bread, coal, iron, and other products, i.e., everything which enriches the country, are the core of all economic policy of our Party. This will make it possible to solve more successfully one of the main problems posed by the 26th CPSU Congress: to increase the efficiency and to raise the intensification of the public production to a new level.

Methods of solving this problem are defined in the resolution of the CPSU Central Committee and USSR Council of Ministers, "On intensifying the work on the economy and rational utilization of the raw-material, fuel-energy and other material resources." This document is a permanent program. It lists a whole complex of organizational, scientific-technical and economic measures for the extensive evolution of the struggle for economy, in which a most active part is taken by the ministries, departments, Party, Soviet, trade-union, and Komsomol organizations, labor collectives, and each worker, kolkhoznik and specialist.

Much attention is given to the fundamental improvement in the procurement and processing of secondary raw materials of ferrous and nonferrous metals. The urgency of this problem has increased sharply in recent years. It is caused by a number of factors. The metal resources of the country, which now exceed one and a half billion tons, have grown considerably. Consequently, the possibilities of enlisting depreciation metal into the economic turnover have been expanded. Waste products in the production and use of metal are still great. About 50 million tons of steel are now being smelted per year from secondary metallurgical raw materials. The Soviet state is at an enormous advantage because of this. Suffice it to say that to produce such a quantity of metal from natural raw materials would require the mining and processing of an additional 190 million tons of iron ore and 75 million tons of coking coal and limestone. But this is still not everything. It is impossible not to consider that specific capital investments for gathering and processing secondary raw metal are 25 times less than that for producing metal from ores.

In short, each ton of procured secondary metallurgical raw material has a special, ever increasing, economic, and even social-public importance, since it satisfies not only the need of the branch for valuable raw materials, but also helps cultivate the prudent attitude toward the already created national wealth. This is the path toward lowering the cost of the productive output, saving fuel and energy and increasing labor productivity. Let us take aluminum as an example. To produce a ton of aluminum from secondary raw material requires 33 times less fuel and six times less capital outlay, and the labor productivity is more than doubled, and the cost of the conversion is seven times lower.

We must consider that reserves of many metals in deposits are limited and unsuppliable. The mining and geological conditions of their extraction become worse, the specific capital investments for the extraction of each ton of ore raw material are increased, and the production cost goes up. How great the responsibility of each, from worker to ministry, should be for the zealous use of the natural resources!

Meanwhile, today many needs of the national economy can be satisfied, having improved the gathering and processing of the secondary metallurgical raw material. This is not so much a branch as a national economic problem of great importance.

This was precisely the topic of discussion at a conference conducted in the middle of July of this year of workers of Party, Soviet and economic organizations. At the conference they analyzed the state of affairs, and defined the trends and practical measures taken on the further increase in the efficiency of the use of secondary metallurgical raw materials, the improvement of planning and organization of their procurement, and the improvement of equipment and technology of processing.

After the 26th Party Congress, there was noticeable activation of the work of ministries and departments and Party, Soviet and public organizations on the involvement into turnover of secondary metallurgical raw materials. The construction of new and reconstruction and modernization of existing plants for processing secondary metals are explored. Much work in this direction is being conducted in Belorussia, Georgia, Uzbekistan, and the Irkutsk, Magadan, Donets, Dnepropetrovsk, Voroshilovgrad, Chelyabinsk, and a number of other oblasts.

A good example of the organization of the matter and cultivation of the workers in the spirit of a prudent attitude toward the national property is shown by the CPSU Rostov Obkom. A complex program on the gathering, processing and use of secondary resources of ferrous and nonferrous metals is being developed and carried out. A distinct system of checking the fulfillment of assignments has been established, and the responsibility of the Party and economic bodies for their fate has been increased. The state of the affairs is regularly considered at a session of the oblast commission on economy and thrift. Once every six months the Party committee together with bodies of the national inspection investigate all the plants, which helps to reveal facts of bad management.

As a whole, as regards the national economy, the plan of procuring secondary metallurgical raw materials for last year and the first half of this year has been successfully fulfilled. More than 7.4 million tons of ferrous and 2.5 million tons of nonferrous metals have been procured.

Moreover, according to the estimate of specialists, due to the incomplete procurement of secondary metallurgical raw materials and the lack of their processing, there is a loss of about 1.5 million tons of metal, including many scarce nonferrous and alloyed components. It is impossible to recognize as normal the fact that in recent years the growth in the procureable secondary metallurgical raw materials has been decreased, although the metal resources of the country, the main source of their formation, are continually being increased. Capacities of procurements of secondary nonferrous metals, beginning from 1978, have been set lower than those actually reached in the preceding year.

Facts of mismanagement and disruptions in the state discipline have been slowly eliminated at the sites. It is no secret that still a large amount of the metal products unsuitable for further operation remains at the industrial sites, is scattered over the territories of populated settlements, is taken to the rubble dumps, and is irretrievably lost. For example, at some mines of the Kuzbass, trolleys, metal timberings and rails were left in the depleted excavations. At the Minsk motor vehicle, Yaroslav engine and Saratov No. 3 bearing plants, copying lathes, old parts of machines, and metal production wastes for a long time are not surrendered for remelting and clutter the territory. The interests of the national economy require that not one kilogram of metal which became obsolete would be lost, so that it is restored in the form of new machines, mechanisms and other material values.

Of course, some wishes and enthusiasms cannot be avoided here. There is need for an approach toward determining resources of secondary metallurgical raw materials, further improving the planning and increasing the planned discipline. In active practice, assignments for procuring and processing scrap metal are often established according to this principle: "every lawyer has his fee." Finally, it is found that some representatives fulfill their plan without special efforts ahead of schedule, caring little about the fact that each ton of shavings and each copying lathe would be dealt with more rapidly. Others, on the other hand, receive overstated assignments, ruin them and bear moral and material losses. It is clear that you do not call such an approach a mobilizing one. Assignments on the procurement of secondary ferrous and non-ferrous metals and the demand to fulfill them should be the same as for plans of producing products.

In the past year, out of the 73 ministries and departments, about one-third did not fulfill their plan and underproduced 250,000 tons of secondary raw materials of ferrous and nonferrous metals. The great underfulfillment was permitted by the construction ministries, USSR Ministry of Construction Materials Minkhimmash, Minpribor, Minradioprom, and also the Penza, Murmansk, Tyumen, and a number of other oblasts. The position has not been improved in the current year.

The efficiency of using secondary metallurgical raw materials is closely connected with the preparation and processing of these materials. The quality of the smeltable metals and alloys and the productivity of the metallurgical aggregates depend on the degree of the materials' preliminary preparation and grading according to types and brands. And much is being done in this direction. But, nevertheless, a large amount of the procurable secondary raw materials--copper, aluminum, brass, bronze, and ferrous metals, including alloyed, arrived in mixed form, which results in considerable losses in non-ferrous metals and the contamination of steel with impurities.

Secondary metallurgy is not a simple production. It is in need of the development of highly efficient industrial processes and the use of the latest equipment. Unfortunately, plans for the construction and reconstruction of its projects are often based upon outdated technological schemes, which provides for the use of only baling presses, cutters and essentially manual laborious grading. Little attention is given to the highly productive mechanized production lines and the incorporation of modern analysis methods of raw materials of complex composition.

In nonferrous metallurgy, due to the lack of technical equipment of many plants of Vtortsvetmet [Secondary Nonferrous Metals Processing], much of the produced secondary aluminum alloys is of low quality. Considerable irreversible losses of copper, zinc, lead, and other nonferrous metals are allowed.

Mechanical engineers play an important role in solving these problems. As an analysis shows, the volumes, nomenclature and qualitative indices of equipment being produced for processing secondary metallurgical raw materials do not satisfy the needs which have grown in them. The USSR Minchermet [Ministry of Ferrous Metallurgy], USSR Mintsvetmet [Ministry of Nonferrous Metallurgy], Mintyazhmash [Ministry of Heavy Machinery Manufacture], and Minstankoprom [Ministry of Machine Tool Industry] are slowly developing the scrap metal processing complexes and equipment for crushing and grading alloyed depreciation metal and nonmetallic impurities. The serial production of new models of equipment is inadmissably being delayed.

There should be a radical change in the attitude toward the construction of projects of secondary metallurgy and the providing of them with plans of contract works and material and technical resources. Many construction ministries refer to them as secondary projects and disrupt the fulfillment of the established assignments. In the past year they fulfilled the plan of construction-installation works for Vtorchermet by 85%, including the USSR Minpromstroy [Ministry of Industrial Construction] by 56%, Minvostokstroy [Ministry of Eastern Construction] by 15%, and Minenergo [Ministry of Energy] and the least, by 7%.

Since 1973 the USSR Minpromstroy repeatedly included in the plan construction of the Tula shops of Vtortsvetmet with a cost of 1.5 million rubles. However, the construction of it has still not begun. At the same time, in this region more than 70% of the secondary raw material of nonferrous metals is of low quality and is sent for remelting without processing.

Of importance for secondary metallurgy are also problems of the selection, placement and assignment of personnel, especially young people, and the transfer of leading experience. Who is doing the teaching here? In the system there are many specialists and workers devoted to their work who understand the problems facing them. Among them we can name managers of the Chelyabinsk Industrial Union and Voroshilovgrad plant of Vtorchermet, comrades Zhigmor and Zyuzin, the senior representative of the Leningrad Union "Vtortsvermet", comrade Dudarev, the representative of the Orenburg plant Vtorchermet, comrade Rybalkin, and many others. Their experience is a valuable contribution to the young people.

It is also important to conduct sequentially the mechanization of labor and create working conditions for fruitful work. It is necessary to use skillfully the moral and material stimuli and show great care in providing the workers with lodging and everyday needs and cultural services. There is a need for improvement in the organizational and political-educational work in the labor collectives, and occasionally its concreteness and efficiency are made adequate. It is necessary to raise to a higher level the socialist competition and show the experience and achievements of leaders and innovators of production in printed material, radio broadcasts and telecasts.

Workers of the plants and organizations of Vtorchermet and Vtortsvermet have accumulated much experience. Recognizing that the efficient use of secondary metallurgy is the real reserve of the more complete satisfaction of the growing needs of the national economy in qualitative metal production, they try to make a worthy contribution to the fulfillment of the socialist obligations in honor of the 60th anniversary of formation of the USSR, the plan for 1982 and the 11th Five-Year Plan as a whole.

9978  
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INFLUENCE OF PHOSPHORUS ON STRUCTURE AND PHYSICAL PROPERTIES OF IRON-NICKEL ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 82  
(manuscript received 15 Jul 81) pp 96-99

BERSENEVA, F. N., KALININ, V. M. and RYBALKO, O. F., Sverdlovsk

[Abstract] A study was made of the structure and properties of iron-nickel alloys (30-50% Ni) containing 0.02 to 0.5 wt.% P. The studies were intended to determine up to what concentrations the phosphorus is completely dissolved in the matrix and at what phosphorus content of phosphide phase is separated. The specimens were melted in a vacuum resistance furnace in a process intended to minimize impurities, nonmetallic inclusions and gases. The total content of all impurities was not over 0.5 wt.%, gases 0.003 wt.%. The solubility of phosphorus was found to be higher than the maximum solubility usually observed in commercial specimens not so free of impurities. A phosphide eutectic was separated along the grain boundaries only at a phosphorus content of 0.45 wt.%. The addition of 0.4 wt.% P increases  $I_S$  and  $T_C$  and results in a more homogeneous magnetic structure. Figures 2; references 6: all Russian.

[172-6508]

UDC 539.27:546.83

ELECTRONOGRAPHIC STUDY OF INTERACTION OF ALUMINUM AND SILICON OXIDES IN THIN FILMS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 82  
(manuscript received 3 Aug 81) pp 162-165

ZAYSTSEV, A. A., KOROTKOV, N. A., LAZAREV, E. M. and FEDORCHUK, N. M., Moscow

[Abstract] The studies were performed using two-layer thin (500-700 Å) films of Al-Si, Al-SiO<sub>2</sub> (semiamorphous), Al-SiO<sub>2</sub> ( $\alpha$ -cristobalite ( $\gamma$ -Al<sub>2</sub>O<sub>3</sub>-Si,  $\alpha$ -Al<sub>2</sub>O<sub>3</sub>-Si), produced by thermal evaporation in a vacuum. The film systems were heated in air to 700-1400°C for 2 hours at each test temperature. The phase composition of the films was studied by the electronographic method. In the two-layer Al-Si thin films with molar ratio of the aluminum and silicon oxides 3:2 and 1:1 at 1175°C a single compound 3Al<sub>2</sub>O<sub>3</sub>·2SiO<sub>2</sub> is formed (mullite)

which is stable up to  $1400^{\circ}\text{C}$ . Mullite is not formed in the other compositions. Evaporation of  $\text{SiO}_2$  and  $\gamma$  to  $\alpha$  phase transition in the  $\text{Al}_2\text{O}_3$  leads to failure of films of these compositions at temperatures over  $1200^{\circ}\text{C}$ . Figures 1; references 8: 6 Russian, 2 Western.  
[172-6508]

UDC: 669.27-172

#### CERTAIN FACTORS DETERMINING QUALITY OF SINGLE TUNGSTEN CRYSTALS GROWN FROM POWDER BY PLASMA METHOD

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 82  
(manuscript received 25 Jan 82) pp 170-174

BURKHANOV, G. S. and SOROKIN, S. R., Moscow

[Abstract] Tungsten powders separated into fractions with mean particle diameters 20, 50, 80 and 130  $\mu\text{m}$  were used as the initial material in these experiments with a content of the primary impurities for all particle sizes as follows, weight %: Fe-0.007; Al-0.002; Ni-0.001; Ca-0.002; P-0.01; S-0.002; Si-0.006; Mo-0.037; C-0.009; O<sub>2</sub>-0.035. A single crystal of tungsten 16 mm in diameter was produced at a growth rate of 1 mm/min to study the influence of mean diameter of powder particles. To study the quantitative variation of impurity content and structural perfection as a function of growth rate, 16-mm diameter single crystals were grown at 0.5, 1, 1.5 and 3 mm/min. A decrease in residual oxygen content and pore content, and an increase in density of single crystals obtained by the plasma arc method were observed with an increase in mean particle diameter of the initial powder. Plasma growth of single crystals at 0.5 to 1.5 mm/min decreases residual carbon and silicon content by more than an order of magnitude. Further increases in growth rate decrease the effectiveness of this purification and result in increases in the content of these elements. Figures 3; references 8: all Russian.

[172-6508]

#### ELECTRON MICROSCOPE STUDY OF INFLUENCE OF ELECTROCHEMICAL WORKING ON SURFACE MICRORELIEF OF ATOMIZED ALUMINUM FILMS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 3, May-Jun 82  
(manuscript received 9 Mar 81) pp 15-17

YUDENKOVA, I. N., ADVENA, V. G., VDOVENKO, I. D., ZUBOVA, V. V. and RETIVOV, V. F., Kiev

[Abstract] A study was made of the possibility of improving the microrelief of the surface of vacuum condensors by anodic electrochemical treatment. Atomized aluminum films were studied before and after electrochemical treatment. The films, 1-4  $\mu\text{m}$  thick, were applied to sital by resistive and electron heating at 100 to 400 A/s, substrate temperature  $573-673^{\circ}\text{K}$ , vacuum 10 to 50 mm Hg.

The microrelief before and after electrochemical working was studied on an electron microscope by the method of carbon replicas, with chromium shadowing at 60 to 70°. Photomicrographs clearly show the possibility of electrochemical working of aluminum films under these conditions, improving the microgeometry of the surface. Figures 1; references 5: all Russian.  
[167-6508]

#### INFLUENCE OF GAS DISCHARGE ON ADHESION STRENGTH OF ALUMINUM FILM-SITAL SYSTEM

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 3, May-Jun 82  
(manuscript received 23 Mar 81) pp 33-35

ABDULLIN, I. Sh., POVODYREVA, I. P. and CHENBORISOV, V. Sh., Kazan'

[Abstract] Aluminum films 0.8 and 1  $\mu\text{m}$  thick were applied to sital substrates at 120°C by thermal vacuum evaporation. Some of the specimens were plasma treated in a gas discharge created by a high frequency low pressure induction plasmotron. The adhesion strength was measured by uniform normal separation testing. The results showed that plasma treatment may either increase or decrease adhesion depending on plasmotron operating conditions. The maximum adhesion under the optimal operating conditions is 1.8 times greater than the poorest adhesion achieved. Optimal conditions are 15 minutes operation at  $G=0.08 \text{ g}\cdot\text{s}^{-1}$ . Figures 2; references 4: all Russian.

[167-6508]

UDC: 539.43

#### STATISTICAL REGULARITIES OF FATIGUE CRACK DEVELOPMENT

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 18, No 3, May-Jun 82 (manuscript received 10 Apr 81) pp 70-74

STEPNOV, M. N., MAKHUTOV, N. A., SEREGIN, A. S. and LISIN, A. N., Institute of Aviation Technology imeni K. E. Tsiolkovskiy, Moscow

[Abstract] This article presents the results of studying probabilistic features of the failure of AK4-1 and D1 aluminum alloys. Specimens of AK4-1 alloy were tested in pure circular flexure; smooth specimens 9 mm in diameter and specimens 14 mm in diameter with a defect made by a 0.3 mm diameter drill to a depth of 0.3 mm were tested. Specimens of D1 alloy were tested in symmetrical flat flexure with rigid loading. Flat specimens 24 x 8 mm were used with a defect 0.2-0.3 mm deep and 1 mm long made with a cylindrical milling cutter 1.5 mm in diameter inclined at an angle of 45° to the surface. The D1 specimens were loaded until a crack 12 to 17 mm in length appeared. It was found that Paris' kinetic equation is a function of two stochastically related random parameters, one of which is independent of the amplitude of stresses or size of the initial defect. The distribution of the parameter ( $n$ ) is normal.

The new parameter  $a = \bar{y}$  is functionally related to the stress amplitude and dimension of the initial defect. Reduction of the experimental results to one amplitude and defect size allows more reliable construction of the distribution function of parameter  $a$ , which was found to be normal. The dispersion of the crack development rate logarithm does not change with increasing crack size and is independent of stress amplitude or initial defect size, being determined by the properties of the material. The crack propagation rate logarithm is normally distributed. Figures 4; references 7: all Russian.

[169-6508]

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